

We Claim:

- 1 1. A method of transmitting optical signals in an optical
2 communication system, comprising:
3 receiving an optical input that has a first data rate;
4 splitting the optical input into a plurality of sub-wavelengths,
5 wherein the plurality of sub-wavelengths are spaced sufficiently close in
6 wavelength to provide a spectral efficiency of all the sub-wavelengths of the
7 plurality of sub-wavelengths that is close to or greater than a spectral
8 efficiency of the optical input;
9 combining the plurality of sub-wavelengths.
- 1 2. The method of claim 1, wherein a total bandwidth occupied
2 by the sub-wavelengths is within a same ITU window of the optical input.
- 1 3. The method of claim 2, wherein the total bandwidth occupied
2 by the sub-wavelengths is less than a bandwidth occupied by the optical
3 input.
- 1 4. The method of claim 2, wherein the total bandwidth occupied
2 by the sub-wavelengths is 5 times or less than a bandwidth occupied by the
3 optical input.
- 1 5. The method of claim 1, wherein the optical input is serial and
2 the plurality of the transmitted sub-wavelengths are parallel.
- 1 6. The method of claim 1, wherein the sub-wavelengths are
2 generated by demultiplexing the optical input into the plurality of sub-
3 wavelengths.

1 7. The method of claim 6, wherein the sub-wavelengths are
2 demultiplexed using all-optical demultiplexing.

1 8. The method of claim 6, wherein the sub-wavelengths are
2 demultiplexed by demultiplexing the optical input into a plurality of
3 electronic signals that one or more optical transmitters.

1 9. The method of claim 1, wherein a plurality of optical
2 transmitters are provided to produce the plurality of sub-wavelengths, each
3 of an optical transmitter including a wavelength locker.

1 10. The method of claim 1, wherein a single optical transmitters
2 is provided and uses subcarrier multiplexed modulation to produce the
3 plurality of sub-wavelengths.

1 11. The method of claim 1, wherein a single optical transmitters
2 is provided and uses optical single side band modulation to produce the
3 plurality of sub-wavelengths.

1 12. The method of claim 7, wherein the plurality of sub-
2 wavelengths from a plurality of optical transmitters are combined by a
3 multiplexer or an optical coupler.

1 13. The method of claim 12, wherein a plurality of optical
2 receivers are provided, each of an optical receiver of the plurality of optical
3 receivers being configured to receive a sub-wavelength.

1 14. The method of claim 13, wherein each of optical receiver
2 includes one of an optical wavelength demultiplexer, an optical splitter, or
3 an optical add-drop multiplexer that separates the plurality of sub-
4 wavelengths.

- 1 15. The method of claim 14, wherein the plurality of sub-
2 wavelengths are introduced to multiple fixed optical to electrical converters.
- 1 16. The method of claim 13, wherein a number of sub-
2 wavelengths is equal to a number of optical receivers.
- 1 17. The method of claim 16, wherein a number of sub-
2 wavelengths is in the range of 4 to 32
- 1 18. The method of claim 1, wherein the first data rate is 10
2 Gb/sec or more.
- 1 19. The method of claim 1, wherein a sub-wavelength data rate
2 of each subwavelength 50 Gb/s or less, and spacing of the sub-wavelengths
3 is 25 GHz or less.
- 1 20. The method of claim 1, wherein a sub-wavelength data rate
2 of each subwavelength is 10 Gb/s or less, and spacing of the sub-
3 wavelengths is in the range of 5 to about 25 GHz.
- 1 21. The method of claim 1, wherein a sub-wavelength data rate
2 of each subwavelength is 10 Gb/s or less, and spacing of the sub-
3 wavelengths is in the range of to about 6 to 25 GHz.
- 1 22. The method of claim 1, wherein a sub-wavelength data rate
2 of each subwavelength is 2.5 Gb/s or less, and spacing of the sub-
3 wavelengths is in the range of to about 3 to 12.5 GHz.
- 1 23. The method of claim 1, wherein a number of subwavelengths
2 is 2 and a sub-wavelength spacing is in the range of 20 to about 100 GHz.
- 1 24. The method of claim 1, wherein a number of subwavelengths
2 is 8 and a sub-wavelength spacing is in the range of 5 to about 25 GHz.

1 25. The method of claim 1, wherein a number of subwavelengths
2 is 4 and a sub-wavelength spacing is in the range of 6 to about 25 GHz.

1 26. The method of claim 1, wherein a number of subwavelengths
2 is 16 and a sub-wavelength spacing is in the range of 3 to about 12.5 GHz.

1 27. The method of claim 1, wherein a number of subwavelengths
2 is 4 and a sub-wavelength spacing is in the range of 3 to about 12.5 GHz.

1 28. A method of transmitting optical signals in an optical
2 communication system, comprising:
3 receiving an optical input that has a first spectral efficiency;
4 splitting the optical input into a plurality of sub-wavelengths,
5 wherein the plurality of sub-wavelengths have a combined spectral
6 efficiency close to or greater than that the first spectral efficiency; and
7 combining the plurality of sub-wavelengths.

1 29. The method of claim 28, wherein a sub-wavelength data rate
2 of each subwavelength is 10 Gb/s or less, and spacing of the sub-
3 wavelengths is in the range of 5 to about 25 GHz.

1 30. The method of claim 28, wherein a sub-wavelength data rate
2 of each subwavelength is 10 Gb/s or less, and spacing of the sub-
3 wavelengths is in the range of to about 6 to 25 GHz.

1 31. The method of claim 28, wherein a sub-wavelength data rate
2 of each subwavelength is 2.5 Gb/s or less, and spacing of the sub-
3 wavelengths is in the range of to about 3 to 12.5 GHz.

1 32. A method of transmitting optical signals in an optical
2 communication system, comprising:
3 receiving an optical input that has a first data rate;

4 splitting the optical input into a plurality of sub-wavelengths,
5 wherein each of a sub-wavelength of the plurality of sub-wavelengths is in a
6 single ITU window; and
7 combining the plurality of sub-wavelengths.

1 33. A long haul optical communication system, comprising:
2 a first optical-to-electronic converter and a first electronic
3 demultiplexer configured to receive and split an optical input into a plurality
4 of sub-wavelengths, the optical input having a first data rate;
5 a plurality of optical transmitters coupled to the first electronic
6 demultiplexer, wherein the plurality of optical transmitters are configured to
7 transmit the plurality of sub-wavelengths with a wavelength spacing
8 sufficiently close to provide a spectral efficiency of all the sub-wavelengths
9 of the plurality of sub-wavelengths close to or greater than a spectral
10 efficiency of the optical input;
11 a first optical multiplexer or first coupler;
12 a second optical demultiplexer, splitter or an OADM; and
13 a plurality of receivers coupled to the optical multiplexer or splitter
14 and the first optical multiplexer or first coupler.

1 34. The system of claim 33 further comprising:
2 a second electronic multiplexer coupled to the plurality of receivers
3 and configured to convert data rates of the plurality sub-wavelengths back
4 to the first data rate.

1 35. The system of claim 33, wherein the first data rate is 10
2 Gb/sec or more.

1 36. The system of claim 33, wherein the plurality of receivers is
2 wavelength-tunable.

1 37. The system of claim 33, wherein the plurality of receivers is
2 not wavelength-tunable.

1 38. The system of claim 33, wherein a number of sub-
2 wavelengths equals a number of receivers.

1 39. The system of claim 33, wherein a number of sub-
2 wavelengths equals a number demultiplexed electronic signals.

1 40. The system of claim 33, wherein a total bandwidth occupied
2 by the sub-wavelengths is within a same ITU window of the optical input.

1 41. The system of claim 40, wherein the total bandwidth
2 occupied by the sub-wavelengths is less than a bandwidth occupied by the
3 optical input.

1 42. The system of claim 40, wherein the total bandwidth
2 occupied by the sub-wavelengths is about 5 times or less than a bandwidth
3 occupied by the optical input.

1 43. A long haul optical communication system, comprising:
2 a first optical-to-electronic converter and a first electronic
3 demultiplexer;
4 an optical transmitter with a common optical carrier coupled to the
5 first electronic demultiplexer, the optical transmitter being configured to
6 modulate the common optical carrier by using demultiplexed electronic
7 signals and splitting an optical input with a first data rate into a plurality of
8 sub-wavelengths, wherein sub-wavelengths of the plurality of sub-
9 wavelengths each have a spectral efficiency close to or greater than a
10 spectral efficiency of the optical input;
11 an optical demultiplexer or optical splitter;

12 a second electronic multiplexer; and
13 a plurality of receivers positioned to receive input from the optical
14 demultiplexer or the optical splitter and produce an output that is coupled to
15 the second electronic multiplexer-

1 44. The system of claim 43, wherein the first data rate is 10
2 Gb/sec or more.

1 45. The system of claim 43, wherein the plurality of receivers is
2 wavelength-tunable.

1 46. The system of claim 43, wherein the plurality of receivers is
2 not wavelength-tunable.

1 47. The system of claim 43, wherein a number of sub-
2 wavelengths equals a number of receivers.

1 48. The system of claim 43, wherein a number of sub-
2 wavelengths equals a number demultiplexed electronic signals.

1 49. The system of claim 43, wherein a total bandwidth occupied
2 by the sub-wavelengths is within a same ITU window of the optical input.

1 50. The system of claim 49, wherein the total bandwidth
2 occupied by the sub-wavelengths is less than a bandwidth occupied by the
3 optical input.

1 51. The system of claim 49, wherein the total bandwidth
2 occupied by the sub-wavelengths is about 5 times or less than a bandwidth
3 occupied by the optical input